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Simultaneously Teaching Conceptual Understanding, Computational Fluency, and Problem-Solving Skills

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Topic: National Math Panel: Critical Foundations for Algebra
Practice: Comprehensive Instruction

Highlights

- Brief overview of the Learning Processes Task Group
- Discussion of the interrelations between conceptual understanding, computational fluency, and problem-solving skills
- Guidance on what teachers can do to integrate these three areas into their classroom instruction
- Examples of how to plan lessons and units that help students develop competence in all three areas
- How to plan units with a range of emphases that aim for closure to ensure proficiency in all three areas
- The important role of teachers' professional wisdom, judgment, and knowledge
- How schools and districts can support teachers
- The impact of student beliefs about effort on mathematics achievement
- What teachers can do to help students engage and persist in problem solving

About the Interviewee

Dr. Joan Ferrini-Mundy served as Ex-Officio Member of the National Mathematics Advisory Panel and as Co-Chair of the Instructional Practices Task Group. She is the Division Director of the National Science Foundation's (NSF) Division of Elementary, Secondary, and Informal Education, in the Directorate for Education and Human Resources. In this role she supports NSF's mission of providing leadership and promoting development of the infrastructure and resources needed to improve pre-kindergarten through 12th grade science, technology, engineering, and mathematics education throughout the United States. While on assignment at NSF, Dr. Ferrini-Mundy serves as a University Distinguished Professor of Mathematics Education at Michigan State University (MSU) and Associate Dean for Science and Mathematics Education in the College of Natural Science. She is a professor in the Departments of Mathematics and Teacher Education.

Ferrini-Mundy's research interests include calculus teaching and learning, the development and assessment of teachers' mathematical knowledge for teaching, and the improvement of student learning in K-12 mathematics. She has played leadership roles in several MSU-based projects, including the Carnegie-supported Teachers for A New Era Initiative, the NSF-funded Knowledge of Algebra for Teaching project, and Promoting Rigorous Outcomes in Mathematics/Science Education (PROM/SE), an NSF Mathematics and Science Partnership.

Full Transcript

I am Joan Ferrini-Mundy and I work currently at the National Science Foundation as Director of the Division of Research on Learning in Formal and Informal Settings. I am fortunate to be here on an IPA, which is an Intergovernmental Personnel Act appointment from my home institution, which is Michigan State University, where I am a member of the mathematics education faculty.

I served on the instructional practices subgroup and worked as co-chair of that group toward the end of the time of the Panel. One of the key messages of the National Mathematics Panel is that instruction should simultaneously develop conceptual understanding, computational fluency, and problem solving. It's an issue to think about what does that really mean in instruction? Do we do this all at once somehow? Do we do this in some sequence? And I think what's important to recognize is that that will vary by teacher, by student, by the topic. In some cases, for example, it might make the most sense to begin by explaining the concept to children directly, say, the concept of how does one actually add fractions. It then might move toward some computational work where children might be asked to try some practice problems, to confer with each other about how to get solutions to actual computation problems. And then a teacher might move toward more interesting, perhaps problem solving, applied problems where children would need to use this newfound concept and computational skill in practice. Or, the lesson might start with the applied problem, it might start with something that could motivate the children and interest them and raise for them the need to be able to add fractions. The point is that a lesson might be only about one piece of this trio of important

mathematical activities, but a unit, a full focus on a topic should engage all three; and children should come away with understanding and competence in all three of these areas.

Teaching mathematics is really complex, and teachers will need to use their professional wisdom and judgment and knowledge to make the best decisions for themselves and their students. I can imagine lessons that are fully focused only on such things as conceptual understanding. I can also imagine lessons that are focused on each of the other two areas separately as well as lessons that try to integrate the three together. There is no simple formula for this. What I would advise teachers to think about as they do their planning, is they think about a unit that would have a range of emphases for students. Aim for a closure to that unit that would include proficiency in all of these areas so that across the several days or even weeks that it takes to complete the unit, teachers have spent time with their students on the computational fluency, on conceptual understanding, and on problem solving, and be able at the end of the unit to have successfully addressed and integrated the three.

So, as teachers plan their lessons and their units, one thing that they can do is look at their instructional materials and think about the ways in which different pieces of instruction can emphasize each of these different areas. If their textbook doesn't include enough emphasis on any one of these three areas, then I would advise teachers to look elsewhere—to seek other resources that might give them ideas about how to strengthen whatever piece is missing in the instructional material. They also can look to their students and try to get a sense of where their students are weaker or stronger, and that can be done through assessment—a careful looking daily at where students are, and then trying to fill in and supplement in ways that will enrich their understandings in these separate three areas.

So in thinking about what schools and districts might do to support teachers as they work to integrate conceptual understanding, problem-solving skills, and computational fluency, there are several things that come to mind. Some of this actually begins at the pre-service education of teachers, where one would hope that universities and colleges that prepare teachers would be attentive to this issue and in their mathematics courses would help teachers to see both how this can be done for undergraduate mathematics, but also to give teachers models and ideas about how it can be done topic by topic for the K through 8 curriculum.

As for schools, what can schools do? Well, schools are full of teachers with wonderful expertise, and I think one thing that can happen inside of schools is that leadership in schools, principals and superintendents in districts, can help to recognize that teachers have a lot to bring to this set of questions, and to make time for teachers to interact with one another, to share best teaching practices, to observe one another in their teaching, to actually consciously look at the inclusion of these three emphases, and then to step back and reflect upon how different lessons have been able to accomplish these things.

Schools can make it possible for teachers to have access to multiple resources that they can examine as they plan their instruction. So one of the key panel messages is that effort counts and that students' mathematics

performance can be improved by their increased effort. The learning processes subgroup of the National Mathematics Panel did a very thorough review of the literature in this area, and they report that research does demonstrate that when students try hard, they really can make gains in mathematics, and that it's very important for teachers and for parents and for all of those of us who engage with students and teachers around math to make this point very clearly—that there is every reason to believe that by trying hard, by working hard, by persisting, you can make gains in mathematics.

One thing that I know, in my own experience as a teacher, is that it's useful to model for students the fact that not every mathematics problem can be solved in one minute or less. I think mixing in some problems that are long term, that are puzzling, that might intrigue and interest children is one way that teachers can help to demonstrate that effort can matter. Another way I suspect is by rewarding effort, within reason, and making sure that students understand that teachers recognize that they are trying hard, and that that's a part of doing mathematics. The idea of expecting students to put substantial effort into mathematics, and for teachers to figure out how to manage that, is a very big challenge to the teacher. Because what it means is that the teacher needs to be finding ways constantly to assess what the student is doing, to say just the right thing or ask just the right question at just the right moment, to encourage the student to move ahead, but not to sort of give away the whole answer to the student. It's an incredibly challenging skill for a teacher and probably one that develops with experience and with time, and probably one that teachers can begin to share with each other in some reasonable way. But I think saying that we need to make it clear that effort matters should be interpreted as, we need to make it clear that teachers have to figure out ways to support their students, keep them motivated, keep them engaged, and keep them trying in ways that aren't punitive but, instead, that are exciting and that are motivational.